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ADJUSTING DEPRECIATION IN AN INFLATIONARY ECONOMY: INDEXING VERSUS ACCELERATION

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ABSTRACT

With the existing "historic cost" method of depreciation, higher inflation rates reduce the real value of future depreciation deductions and therefore raise the real net cost of investment. The calculations in this paper show that this rise in the net cost can be quite substantial at recent inflation rates; e.g., the real net cost of an equipment investment with a 13 year tax life is raised 21 percent by an 8 percent expected inflation rate if the firm uses a 4 percent real discount rate.

The effects of inflation on the net cost of investment can be completely eliminated by indexing depreciation. A more accelerated depreciation schedule can also lower the net cost of investment and make that net cost less sensitive to the rate of inflation. The current paper examines a particular acceleration proposal and finds that, for moderate rates of inflation and real discount rates, the acceleration proposal and full indexation are quite similar. For low rates of inflation, high discount rates, or very long-lived investments, the acceleration proposal causes greater reductions in net cost than would result from complete indexing. Conversely, for high rates of inflation, low discount rates, or very short-lived investments, the acceleration method fails to offset the adverse effects of inflation.

Since the acceleration and indexation methods have quite similar effects under existing economic conditions, the choice between them requires balancing the administrative simplicity and other possible advantages of acceleration against the automatic protection that indexation offers against the risk of significant changes from the recent inflation rates and discount rates.

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Adjusting Depreciation in an Inflationary Economy: Indexing Versus Acceleration

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Under existing law, the depreciation of plant and equipment that firms may claim in calculating taxable income is limited to the original or "historic" cost of the investment. The annual depreciation allowances are not adjusted when there are increases in the general price level or in the cost of replacing the particular asset. A higher rate of inflation therefore lowers the real value of the depreciation allowances on any investment.[1] Since depreciation allowances reduce a firm's net cost of making an investment, a higher rate of inflation raises the net cost of investing.[2] The combination of inflation and existing tax laws thus discourages investment in depreciable plant and equipment and, by making investment less profitable, may reduce the economy's rate of saving. Moreover, since the reduction in the value of the depreciation that is caused by inflation depends on the life of the asset, inflation also distorts the choice between short-lived and long-lived equipment and thereby reduces the productivity of the capital stock.

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[1]According to estimates by the Department of Commerce, the depreciation allowances of nonfinancial corporations in 1978 would have been 40 percent greater than the $114 billion actually allowed if depreciation were based on the replacement cost of the assets instead of their historic cost. Feldstein and Summers (1979) discuss the comparable figures for earlier years.

[2]This is equivalent to an increase in the effective tax rate on capital income. Feldstein and Summers (1979) show that in 1977 the use of historic cost depreciation raised the total effective tax rate on nonfinancial corporations and their owners by nearly 14 percentage points.

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Several economists have pointed out that these adverse effects of inflation on the value of depreciation allowances could be eliminated completely by changing from historic cost depreciation to a method of indexed depreciation.[1] The simplest such scheme would adjust the value of allowable depreciation each year for the rise in the consumer price index since the previous year.[2] Although depreciation allowances have been indexed in this way in a few countries with very high inflation rates[3], it has been common in most other countries to deal with inflation by reducing the number of years over which an asset can be depreciated.[4]

In the United States, some tax experts have advocated shorter depreciation lives instead of indexed depreciation on the ground that acceleration is much simpler than indexation for taxpayers to use and that such administrative simplicity saves real resources. This is particularly true of proposals to "expense" investment (immediate write-off) or to depreciate all kinds of equipment over the same number of years. It is further argued that indexing depreciation might

[1]See, for example, Feldstein, Green and Sheskinski (1978), Fellner (1975), Galper and Mendenhall (1976), International Monetary Fund (1975), Shoven and Bulow (1975), and the papers in Aaron (1976) and Tax Foundation (1975.)

[2]An alternative method of indexing depreciation would adjust each type of asset by a different price index in an attempt to reflect differences in the rates of change of replacement cost. Since adjusting for changes in the relative prices of different assets and in the relative prices of consumption and investment goods is really a separate issue from overall inflation adjustment, I will limit my discussion to adjustments based on the consumer price index.

[3]These include Argentina, Brazil and Israel. See the descriptions of the Brazil and Israel methods in Nadiri and Pastore (1977.)

[4]For example, for a broad range of equipment investments, Canada allows a two-year write-off while the United Kingdom allows immediate expensing.

lead to other kinds of indexing that reduce the overall stability of the economy.[1] Yet another argument in favor of acceleration is that it can be used to provide an incentive for investment spending above and beyond merely offsetting the adverse effects of inflation.

Proponents of indexing have countered that a shortening of depreciation periods is inferior to indexing in three important ways. First, any specific shortening of depreciation lives may be either inadequate or too generous at existing inflation rates. Second, since the proposed shorter depreciation lives do not depend explicitly on the rate of inflation, the benefit of shorter lives would more than offset the effect of inflation when the future inflation rate is low but would fail to offset it when the inflation rate is high. Third, for any rate of inflation, using an arbitrary short depreciation life benefits long-lived investments more than short-lived investments and thereby distorts choices among assets of different durability. The correct choice between the administratively simpler acceleration approach and the more precisely appropriate indexing depends on how well acceleration approximates indexing over the relevant range of asset lives, interest rates and inflation rates.[2,3]

The primary purpose of the present paper is to provide just such a

[1]See Fischer (1977) and Gray (1976) for analyses of the conditions under which general indexing may be destabilizing.

[2]My colleague, Dale Jorgensen, points out that all of the benefits of indexing could be achieved by allowing an immediate deduction of the entire present value of the future real depreciation whenever an investment is made. In practice, this would be equivalent to expensing a fraction of the initial cost that varies inversely with the life of the asset. Selecting the fraction requires choosing (actually or implicitly) a real discount rate for calculating the present value.

[3]More rapid depreciation may also bias patterns of ownership and leasing because of the differences in marginal tax rates.

comparison of the relative effects of acceleration and indexing on the firm's net cost of investment. The effects of both methods are calculated for a wide range of asset lives, interest rates and inflation rates. With these calculations, it is possible to analyze how the relative impact of the two methods differs according to the inflation rate for a given asset as well as how it varies among assets of different lives for a given inflation rate. The paper also provides evidence on the extent to which inflation and the existing historic cost depreciation method now raise the net cost of investment and distort the mix of long-lived and short-lived investments.

There are, of course, many different ways in which shorter lives, more rapid acceleration schedules and increased investment tax credits can be combined to reduce the net cost of investment. Although the calculations described below were initially made for several different such acceleration combinations, I decided to focus the presentation of results on a particular acceleration proposition that has been receiving substantial attention in tax policy circles. Two key members of the House Ways and Means Committee, James Jones and Barber Conable, recently introduced a bill that would permit structures to be depreciated in 10 years, equipment (except automobiles and light trucks) to be depreciated in five years, and autos and light trucks to be depreciated in three years.[1] The annual depreciation amounts[2] for the shorter lives are calculated on an accelerated schedule which is essentially the sum-of-

[1]The proposed legislation is HR4646 of the 96th Congress, known as the Capital Cost Recovery Act of 1979. Jones is an Oklahoma Democrat and Conable is a New York Republican. The Senate sponsors of the bill are Lloyd Bentsen (D, Texas), Bob Packwood (R, Ore.) and Gaylord Nelson (D, Wisconsin.)

[2]The bill refers to the annual depreciation amounts as "capital cost recovery allowances" to emphasize that these are not intended as measures of actual economic depreciation.

the-years'-digits method.[1] The proposal also calls for extending the full 10 percent investment tax credit (ITC) to all equipment (other than autos and light trucks) and providing a six percent ITC for autos and light trucks.

The first section of the paper describes the measure of the net cost of investment that will be used to assess the impact of inflation and the effects of the indexing and the acceleration methods. Section two then shows how, with the existing method of historic cost depreciation, inflation raises the net cost of investment. The third section presents the key comparisons of the net costs of investment under the indexing and acceleration methods for different inflation rates and asset lives.

In the end, each reader must decide for himself whether the acceleration method approximates the indexing method closely enough to justify the selection of the simpler but less accurate method of adjusting depreciation to avoid the adverse effects of inflation.

1. The Net Cost of Investment

The net cost to a firm of acquiring any piece of plant or equipment is the difference between the market price of the asset and the present value of the reductions in tax liabilities due to the investment tax credit and future depreciation allowances. Consider, for example, a machine with a market price of $100 and an allowable life of 13 years. The 10 percent investment tax credit (ITC) causes an immediate tax saving of $10. With historic cost depre-

[1] For equipment, the percentages of the initial costs to be allowed in the first five years are 20%, 32%, 24%, 16% and 8%; the low percentage in the first year reflects the "half-year" convention of allowing one-half of a full year's depreciation during the first year. For buildings, the depreciation is 10 percent in the first year, 18 percent in the second year, and then declines at 2 percent a year. For vehicles, the depreciation is 33 percent, 45 percent and 22 percent, which are the percentages obtained by using the double declining balance method.

ciation, the $100 original cost of the machine causes a $100 reduction in taxable income over the life of the machine. With a 46 percent marginal rate of corporate income tax, the $100 reduction in taxable income lowers taxes by $46. The present value of this tax saving depends on the method of depreciation and the firm's rate of discount. This present value is greatest if the firm uses the sum-of-the-years'-digits method. With this method of depreciation, a 13 year tax life, and a discount rate of 10 percent, the $46 of tax savings through depreciation has a present value of $29.84. The net cost of the investment is thus the $100 purchase price minus the $10 ITC and the present value of future tax savings of $29.84, i.e. a net cost of $60.16.[1]

Table 1 shows the present-value net cost of acquiring a $100 piece of equipment under the existing tax law but in the absence of inflation.[2] The calculations assume that the investor is subject to a 46 percent corporate tax rate and chooses the depreciation method that achieves the lowest net cost. The figures in Table 1 show how a higher discount rate, by reducing the present value of future depreciation deductions, raises the net cost of investment. Comparing the net costs for equipment with a three year tax life and an 8 year tax life shows that the eligibility of the 8 year equipment for the full investment tax credit outweighs the slower rate of depreciation. Further increases in the tax life of an asset raise the net cost of investment whenever there is a positive discount rate. Analogous calculations for structures, presented in the lower half of the table, show the effect of

[1]The nearly 40 percent reduction in the net cost of the investment can be regarded as a partial offset to the 46 percent rate of tax levied on future earnings. Samuelson (1964) has shown that a tax on profits will not distort investment decisions only if complete economic depreciation is allowed.

[2]The calculations assume that the investment is not eligible for the 20 percent additional first year depreciation.

Table 1

The Net Cost of Investment in Equipment and Structures

with Existing Tax Laws and No Inflation

Real Discount Rate	Allowable Depreciation Life (Years) 3	8	13	18	25	35
			Equipment			
0.0	50.67	44.00	44.00	44.00	44.00	44.00
0.04	53.21	49.51	51.90	54.08	56.81	60.18
0.07	54.93	52.95	56.46	59.47	63.00	66.98
0.10	56.52	55.91	60.16	63.61	67.44	71.47
			Structures			
0.0	-	54.00	54.00	54.00	54.00	54.00
0.04	-	60.64	63.81	66.62	70.02	74.02
0.07	-	64.65	69.16	72.83	76.91	81.19
0.10	-	68.02	73.31	77.32	81.46	85.44

All figures indicate the net present value cost per $100 of equipment or structures acquired. Calculations are based on equation 1.1 with the half-year depreciation convention.

limiting the investment tax credit and the sum-of-the-years'-digits method to equipment. The net cost of a given structures investment is higher than an equal investment in equipment and the difference grows with the allowable depreciation life of the asset for any positive discount rate.

The net cost of acquiring $100 of investment goods is a useful measure of how inflation and different depreciation methods affect the incentive to invest and the choice among assets of different durability. An increased rate of inflation raises the net cost under existing tax rules while a shorter depreciation life lowers the net cost. To interpret changes in the net cost, it is useful to bear in mind that a rise in the net cost of investment has essentially the same effect on the internal rate of return as an equiproportionate fall in the annual operating profits (i.e., sales revenue minus operating costs, or quasirents.) Equivalently, the internal rate of return on an investment can be maintained when the net cost rises if the annual operating profits rise by the same percentage.[1]

The internal rate of return is of course an alternative measure of the effect of changes in tax rules or the inflation rate. However, comparing internal rates of return requires specifying the pretax income of the investment and the true pattern of economic depreciation.[2] The relation between the

[1]This homogeneity property holds precisely when the discount rate used to calculate the net cost is the internal rate of return on the profit. This is shown formally in Appendix A.

[2]There are other related ways of assessing the impact of inflation and the depreciation method. Auerbach (1979) suggests the relative change in the gross rate of return that must be earned on an investment to produce a previously fixed real net-of-tax yield to investors; see also King (1977). Feldstein and Summers (1978) suggest the maximum potential net rate of return that can be paid to investors on the basis of a given pretax real return. Both of these approaches are useful in other contexts but require specifying the economic life of the asset, the time profile of output, the method of financing the investment, and the pretax or post-tax rate of return.

change in the net cost of investment and the change in the internal rate of return depends in particular on the economic life of the investment and the allowable speed of depreciation. For an investment that lasts forever and produces a constant perpetual yield, a rise in the net costs induces an equal percentage fall in the rate of return. As the economic life gets shorter, the proportionate change in the rate of return for any given change in the net cost increases. For very short-lived investments, a relatively small change in net cost can imply a quite large change in the rate of return if there is no change in operating profits.[1] With typical economic lives and pretax rates of return, the relative changes in the internal rates of return are similar to the change in net costs.[2]

In practice, a change in the initial net cost of investments will cause changes in both the internal rate of return and the annual operating profits. The relative importance of these two changes will depend essentially on the supply elasticity (with respect to the rate of return) of funds for business investment and on the demand elasticity for the products of such investments with respect to their relative price.[3] If the supply of funds is perfectly

[1]To take an extreme example, consider an investment with a one year life, a net cost of $100 and a rate of return of 10 percent. A 5 percent increase in the net cost cuts the return in half while a 10 percent increase in net cost eliminates the entire return.

[2]Consider, for example, an equipment investment with an 11 percent pretax return, a 13 year allowable tax depreciation, and exponential decay of gross operating profits at 7.7 percent a year until the equipment is scrapped at the end of 13 years. As the inflation rate rises from 4 percent to 8 percent, the net cost under the acceleration proposal rises by 5 percent while the internal rate of return falls by 7.6 percent (from 10.5 percent to 9.7 percent.) A further increase in inflation from 8 percent to 12 percent raises the net cost under accelerated depreciation by an additional 5 percent while the internal rate of return falls by an additional 7.2 percent. Other examples are presented in Appendix B of this paper.

[3]This statement oversimplifies because the operating profits depend on the product price relative to wages and other input prices and because the relative price of the investment goods themselves may change in response to their demand.

elastic,[1] a change in the net cost must leave the rate of return unchanged and therefore must raise the annual operating profits by the same percentage as the rise in net cost. Appendix A to this paper presents a simple general equilibrium model and analyzes the implications of differences in the relative supply and demand elasticities.

To appreciate the magnitude of any given change in net cost, it may also be useful to compare it with the equivalent change in the investment tax credit. For example, a $100 investment with a 13 year life has a net cost of $51.90 when evaluated at a real discount rate of 4 percent in the absence of inflation. A 10 percent rise in this net cost is therefore equivalent to reducing the investment tax credit by $5.19, i.e., by 5.19 percentage points from 10 percent to 4.8 percent.

The remainder of this section specifies the formulae for calculating the net cost of investment under the three depreciation methods that will be compared empirically in sections 2 and 3: (1) historic cost depreciation with existing lives, (2) indexed depreciation with existing lives, and (3) the specific method of acceleration described above.

Historic Cost Depreciation

Consider an asset that can be depreciated over T years. The economic life of the asset, i.e., the number of years until it is scrapped, may also be T years but it need not be; the economic life of the asset is irrelevant in calculating

[1]The elasticity of the supply of funds for business investment depends not only on the responsiveness of saving but also on the competing demands for funds (for housing and government spending) and on the international mobility of capital. A common assumption in studies of investment behavior has been that the supply of funds is perfectly elastic; see e.g., Hall and Jorgenson (1967) and Eisner (1978). Feldstein and Summers (1978) found that the supply of funds for business investment appears to be very elastic, i.e., that changes in the potential internal rate of return caused by changes in tax rules cause only very small changes in market rates.

and comparing the net costs of the investment.

The fraction of the initial cost of the asset that can be deducted as a depreciation expense in year t of the asset's life under the existing historic cost method of depreciation will be denoted DH_t. If τ is the corporate tax rate, the reduction in other tax liabilities in year t is τDH_t. With the straight-line method of depreciation, $DH_t = 1/T$ in each year. As noted above, the optimal policy is to use the sum-of-the-years'-digits method which makes $DH_t = 2(T-t+1)/T(T+1)$.[1,2]

Let r denote the <u>real</u> discount rate that firms use to calculate the present value of the future tax savings that result from allowable depreciation[3]. In the absence of inflation, the net cost per dollar of investment can be written:

$$C_H = 1 - ITC - \tau \sum_{t=1}^{T} \frac{DH_t}{(1+r)^t} \tag{1.1}$$

where ITC is the investment tax credit rate for the particular type of investment. The subscript H on C_H indicates that this calculation is based on historic cost depreciation with existing asset lives.

Inflation reduces the real value of the depreciation allowed in future years. These future tax savings can be valued at the prices prevailing at the time of the investment by dividing each year's depreciation by the ratio of the price level in that year (P_t) to the price level at the time of the ini-

[1] In the calculations presented below, I assume the "half year convention" that places the investment at the midpoint of a year.

[2] Most structures are not eligible for the sum-of-the-years'-digits method but are eligible for the 150 percent declining balance method.

[3] Because the nominal values of these tax savings are essentially known when the investment is made, the rate at which they are discounted may be lower then the rate at which other net receipts are discounted.

tial investment (P_o). If the inflation rate is constant at 100 i percent a year, $P_t/P_o=(1+i)^t$ and the real value of the depreciation in year t is $DH_t(1+i)^{-t}$. The net cost per dollar of investment can be calculated by discounting the resulting real depreciation at the original real discount rate, r:[1]

$$(1.2) \qquad C_H = 1 - ITC - \tau \sum_{t=1}^{T} \frac{DH_t}{(1+i)^t (1+r)^t}$$

Indexed Depreciation

The basic idea in indexed depreciation is to adjust each year's allowable depreciation for the increase in the price level since the asset was purchased. This has the effect of making the real value of depreciation in each year of the asset's life independent of the rate of inflation. If P_o denotes the price level at the time the investment is made and P_t denotes the price level t years later, the allowable depreciation with the indexing method is $DI_t = (P_t/P_o)\ DH_t$. If the inflation rate is constant at i, $P_t/P_o = (1+i)^t$ and $DI_t = (1+i)^t\ DH_t$. The increase in the nominal amount of allowable depreciation exactly offsets the fall in the real value of the dollar and

[1]An alternative and essentially equivalent approach is to discount the nominal depreciation amounts by a nominal discount rate equal to the sum of the inflation rate and the original real discount rate. The resulting expression for C_H differs from that in equation 1.2 only by a second-order term that disappears if discounting is continuous.

leaves the net cost of investment independent of the rate of inflation:

$$(1.3) \qquad C_I = 1 - ITC - \tau \sum_{t=1}^{T} \frac{DH_t (1-i)^t}{(1+r)^t \, (1+i)^t}$$

$$= 1 - ITC - \tau \sum_{t=1}^{T} \frac{DH_t}{(1+r)^t}$$

Reduced Depreciation Lives

Shortening the allowable depreciation life changes the values of the DH_t's but does not make any explicit adjustment for changes in the price level. If we let T* denote the new shorter depreciation life for the asset, ITC* the new rate of investment tax credit, and DA_t the fraction of the initial cost that is deducted in year t, the net cost of investment can be written:

$$(1.4) \qquad C_A = 1 - ITC^* - \tau \sum_{t=1}^{T^*} \frac{DA_t}{(1+i)^t \, (1+r)^t}$$

If the sum of-the-years'-digits method is applied with the new shorter life, the depreciation in year t rises from $DH_t = 2(T-t+1)/T(T+1)$ to $DA_t = 2(T^*-t+1)/T^*(T^*+1)$. For example, reducing T from T=10 years to T*=5 years raises the first year depreciation from 18 percent of the initial cost to 33 percent of the initial cost.

Comparing C_I in equation 1.4 and C_A in equation 1.5 shows that the relative net costs under these two ways of changing the current depreciation method will depend on the rate of interest, the rate of inflation, the depreciation life of the asset, and the proposed method of accelerating depreciation.

2. Inflation and the Cost of Investment with Existing Tax Rules

Before comparing the effects of indexing and acceleration, it is useful to examine the way in which inflation raises the net cost of investment with existing tax rules. Table 2 presents the ratio of the net cost of equipment investment with the specified rate of inflation divided by the net cost when there is no inflation. These relative net cost ratios are presented for different combinations of the real discount rate and the allowable tax life. The corresponding ratios for investments in structures are presented in Table 3.

Consider, for example, the effect of an 8 percent sustained rate of inflation on the relative net cost of an investment in equipment. With a real discount rate of 4 percent (i.e., a nominal discount rate of approximately 12 percent), the net cost of investment for a 13 year piece of equipment is 21 percent higher than it would be if there were no inflation. In comparison to the net cost of $51.90 in the absence of inflation that was shown in Table 1, the 8 percent inflation raises the net cost to $62.56.[1] With a lower rate of discount the increase in the net cost is greater; e.g., lowering the nominal discount rate from about 12 percent to 8 percent (i.e., a real discount rate of zero) raises the cost increase from 21 percent to 31 percent. Raising the nominal discount rate to about 15 percent reduces the cost increase from 21 percent to 16 percent. Thus for any plausible discount rate, the 8 percent inflation rate causes a substantial rise in the net cost of investment.

An increase in the allowable tax life of the asset generally increases the sensitivity of its net cost to inflation.[2] With a real discount rate of 4

[1]Since abolishing the entire investment tax credit would raise the net cost of investment from $51.90 to $61.90, the 8 percent inflation has a greater effect than eliminating the entire ITC.

[2]Only with high discount rates and very long lives is this reversed. Auerbach (1979) shows that, with his alternative measure of the distorting effect of investment, the extra cost decreases monotonically with the durability of the investment if there is exponential depreciation and a fixed real net rate of return.

Table 2

The Relative Net Cost of Equipment Investment

with Existing Historic Cost Depreciation Rules

Real Discount Rate	Inflation Rate	Allowable Depreciation Life (Years)					
		3	8	13	18	25	35
0.0	0.00	1.00	1.00	1.00	1.00	1.00	1.00
	0.04	1.05	1.13	1.18	1.23	1.29	1.37
	0.08	1.09	1.23	1.31	1.39	1.47	1.56
	0.12	1.13	1.31	1.41	1.50	1.58	1.67
	0.16	1.17	1.38	1.49	1.58	1.66	1.75
0.04	0.00	1.00	1.00	1.00	1.00	1.00	1.00
	0.04	1.04	1.09	1.12	1.13	1.14	1.15
	0.08	1.08	1.17	1.21	1.22	1.23	1.23
	0.12	1.12	1.23	1.27	1.29	1.30	1.28
	0.16	1.15	1.29	1.33	1.34	1.34	1.32
0.07	0.00	1.00	1.00	1.00	1.00	1.00	1.00
	0.04	1.04	1.08	1.09	1.09	1.09	1.09
	0.08	1.08	1.14	1.16	1.16	1.16	1.14
	0.12	1.11	1.19	1.21	1.21	1.20	1.18
	0.16	1.14	1.24	1.25	1.25	1.23	1.20

Each figure in the table is the ratio of the net cost of equipment investment with the specified rate of inflation divided by the net cost when there is no inflation.

percent or more, there is little extra rise in the relative net cost for increases in the asset life beyond 13 years. But inflation clearly raises the net cost of short-lived investments by relatively less than the increase in the net cost of long-lived assets and therefore biases the pattern of investment in favor of short-lived assets.

The relative increases in the net cost of investments in structures that are shown in Table 3 are very similar to the corresponding figures for equipment in Table 2. This represents two offsetting factors. Because structures are not eligible for the investment tax credit or the sum-of-the-years'-digits method of depreciation, the net cost of an investment in structures is higher in the absence of inflation; this was shown in Table 1. The lower rate of depreciation also means that inflation causes a greater absolute increase in the net cost of investment. Since the two increases are of approximately equal proportions, the increase in the relative net cost is about the same. For example, in the absence of inflation, a structure with an 18 year life would have a net cost of $66.62 per $100 of investment at a 4 percent discount rate. This is 23 percent higher than the net cost of $54.08 per $100 of equipment investment with the same depreciation life and discount rate. An 8 percent inflation would raise the net cost of the investment in structures to $79.98, an increase of $13.36 or 20 percent. Similarly, an 8 percent inflation would raise the net cost of equipment investment by $12.11 or 22 percent. The cost of investment in structures is thus 21 percent higher than the cost of a comparable investment in equipment. As a result, the relative net cost ratios in Tables 2 and 3 are very similar: 1.22 for equipment and 1.20 for structures.

3. Indexing versus Acceleration

Indexing keeps the net cost of investment independent of the rate of

Table 3

The Relative Net Cost of Investment in Structures

with Existing Historic Cost Depreciation Rules

Real Discount Rate	Inflation Rate	Allowable Depreciation Life (Years)				
		8	13	18	25	35
0.0	0.00	1.00	1.00	1.00	1.00	1.00
	0.04	1.12	1.18	1.23	1.30	1.37
	0.08	1.22	1.31	1.38	1.46	1.53
	0.12	1.30	1.40	1.47	1.55	1.62
	0.16	1.36	1.47	1.54	1.61	1.67
0.04	0.00	1.00	1.00	1.00	1.00	1.00
	0.04	1.09	1.11	1.12	1.13	1.12
	0.08	1.16	1.19	1.20	1.20	1.18
	0.12	1.21	1.25	1.25	1.24	1.22
	0.16	1.26	1.29	1.29	1.28	1.24
0.07	0.00	1.00	1.00	1.00	1.00	1.00
	0.04	1.07	1.08	1.08	1.08	1.07
	0.08	1.13	1.14	1.14	1.13	1.11
	0.12	1.17	1.18	1.18	1.16	1.13
	0.16	1.21	1.22	1.20	1.18	1.14

Each figure in the table is the ratio of the net cost of investment in structures with the specified rate of inflation divided by the net cost when there is no inflation.

inflation. Although shortening the depreciation life to 5 years for equipment[1] reduces the sensitivity of the net cost to the rate of inflation, it still leaves some dependence of the real net cost on the rate of inflation. For low enough rates of inflation and for relatively long depreciation lives, the acceleration proposal[2] reduces net cost by more than indexing would. For higher rates of inflation and assets with shorter lives under existing tax rules, the acceleration proposal fails to compensate for the increased rate of inflation.

Table 4 shows the ratio of the net cost of equipment investment under the acceleration proposal to the net cost under the indexing proposal. Since indexing would maintain the same real net cost under every inflation rate (including no inflation), the figures in Table 4 also show the ratio of the real net cost under acceleration to what the real net cost would be under the existing tax law if there were no inflation.

The figures in Table 4 indicate that the specific acceleration proposal is a quite close approximation of indexing at moderate rates of inflation and real interest. This also implies that the acceleration would essentially offset fully the effects of inflation under existing historic cost depreciation. Consider, for example, equipment with an allowable depreciation period of 13 years, an economy with an 8 percent rate of inflation, and an investor with a 4 percent real rate of discount. Table 2 showed that, with the existing

[1]Recall that the proposal described in the introduction refers to all equipment other than automobiles and light trucks (which would have depreciation lives of 3 years.) I use the term "equipment" to refer to equipment other than autos and light trucks.

[2]I use the term "acceleration proposal" to refer to the reduced lives and changes in investment tax credit that are described in the introduction.

Table 4

The Relative Net Cost of Equipment Investment

with the Acceleration and Indexing Proposals

Real Discount Rate	Inflation Rate	Allowable Depreciation Life Under Existing Law (Years)					
		3	8	13	18	25	35
0.0	0.00	0.87	1.00	1.00	1.00	1.00	1.00
	0.04	0.94	1.08	1.08	1.08	1.08	1.08
	0.08	1.00	1.15	1.15	1.15	1.15	1.15
	0.12	1.05	1.21	1.21	1.21	1.21	1.21
	0.16	1.10	1.27	1.27	1.27	1.27	1.27
0.04	0.00	0.89	0.96	0.92	0.88	0.84	0.79
	0.04	0.96	1.03	0.98	0.94	0.89	0.84
	0.08	1.01	1.08	1.03	0.99	0.94	0.89
	0.12	1.05	1.13	1.08	1.04	0.99	0.93
	0.16	1.09	1.18	1.12	1.08	1.02	0.97
0.07	0.00	0.91	0.94	0.88	0.84	0.79	0.75
	0.04	0.96	1.00	0.94	0.89	0.84	0.79
	0.08	1.01	1.05	0.98	0.93	0.88	0.83
	0.12	1.05	1.09	1.02	0.97	0.92	0.86
	0.16	1.09	1.13	1.06	1.01	0.95	0.89

Each figure in the table is the ratio of the net cost of equipment investment with the acceleration proposal divided by the net cost of the investment with complete indexing.

historic cost depreciation rule, the 8 percent inflation rate raised the net cost of investment by 21 percent. Table 4 shows that the acceleration proposal would eliminate almost all of the increased cost under these circumstances. In particular, the real net cost is only three percent higher with the shortened depreciation life than it would be with complete indexation.

Table 4 also shows that acceleration favors longer lived investments.[1] With a 4 percent real discount rate and an 8 percent rate of inflation, the net cost per dollar of investment is 9 percent higher for an investment with an 8 year life than for an investment with an 18 year life. With a real discount rate of 7 percent, the extra cost is 12 percent higher. This bias toward longer lived investments is slightly stronger than the bias toward shorter lived investments that prevails under existing tax rules.

The relative net cost of acceleration and indexing remains between 0.9 and 1.1 for almost all combinations of real discount rates between 4 and 7 percent, inflation rates between 4 and 12 percent, and lives between 3 years and 25 years.[2] Within this "band" between 90 percent and 110 percent of the indexed cost, the "acceleration-to-indexation" net cost ratio is higher for short lived assets, higher inflation rates and lower real discount rates. If the discount rate is very low or the inflation rate is very high, acceleration is not able to eliminate the effects of inflation.

The results are quite similar for investments in structures. Table 5 shows that the acceleration proposal and complete indexing produce approximately equal

[1]The comparison is complicated by the change in the ITC under the specific acceleration proposal which would also reduce the cost of very short-lived investments.

[2]Note that a 5 percent difference is equivalent to changing the investment tax credit by 2.5 to 3.0 percent while a 10 percent difference is equivalent to changing the investment tax credit by 5 to 6 percent.

Table 5

The Relative Net Cost of Investment in Structures

Under the Acceleration and Indexing Proposals

Real Discount Rate	Inflation Rate	Allowable Depreciation Life Under Existing Law (Years)				
		8	13	18	25	35
0.0	0.00	1.00	1.00	1.00	1.00	1.00
	0.04	1.11	1.11	1.11	1.11	1.11
	0.08	1.21	1.21	1.21	1.21	1.21
	0.12	1.28	1.28	1.28	1.28	1.28
	0.16	1.34	1.34	1.34	1.34	1.34
0.04	0.00	0.99	0.94	0.90	0.86	0.81
	0.04	1.08	1.02	0.98	0.93	0.88
	0.08	1.14	1.09	1.04	0.99	0.94
	0.12	1.20	1.14	1.09	1.04	0.98
	0.16	1.24	1.18	1.13	1.08	1.02
0.07	0.00	0.99	0.93	0.88	0.83	0.79
	0.04	1.06	0.99	0.94	0.89	0.84
	0.08	1.11	1.04	0.99	0.94	0.89
	0.12	1.16	1.08	1.03	0.97	0.92
	0.16	1.19	1.12	1.06	1.00	0.95

Each figure in the table is the ratio of the net cost of investment in structures with the acceleration proposal divided by the net cost of the investment with complete indexing.

real net costs of investment if the real discount rate is between 4 percent and 7 percent and the inflation rate is between 4 percent and 12 percent. When there is little or no inflation, the proposed shortening of lives obviously reduces the net cost by more than indexing would. Conversely, if the inflation rate is high or the discount rate is low, the shortening of lives does not reduce the net cost enough to offset the effect of inflation.

4. Conclusion

A firm's real net cost of investing in plant and equipment depends on the investment tax credit and the present value of the future real depreciation deductions. With the existing historic cost method of depreciation, a higher rate of inflation reduces the real value of future depreciation deductions and therefore raises the real net cost of investment.

The calculations presented in the paper show that the rise in the net cost per dollar of investment can be quite substantial. The real net cost of an equipment investment with a 13 year tax life is raised 21 percent by an 8 percent expected inflation rate if the firm uses a real discount rate of 4 percent (i.e., a nominal discount rate of 12 percent). For any real discount rate, inflation raises the net cost relatively more for long-lived assets than for assets with shorter tax lives, thereby distorting the pattern of investment in favor of short-lived investments.

The effects of inflation on the net cost of investment can be completely eliminated by an indexing rule that adjusts the cost base for the rise in the general price level. A more accelerated depreciation schedule can also lower the net cost of investment and make that net cost less sensitive to the rate of inflation. The current paper examines a particular acceleration proposal (that essentially provides a 5 year life for all equipment and a 10 year life for all structures) and finds that, for moderate rate of inflation and real discount rates, the acceleration proposal and full indexation are quite similar. For low rates of inflation, high discount rates, or very long-lived investments, the acceleration proposal causes greater reductions in net cost than would result from complete indexing. Conversely, for high rates of inflation, low discount rates, or very short-lived investments, the acceleration method fails to balance the adverse effects of inflation on the net cost of investment.

Advocates of the acceleration method argue that it can achieve the same desirable offset to the adverse effect that inflation has on the cost of investment as indexing can, but without the administrative complexities of indexing or the risk of an economically destabilizing extension of the indexing principle to other aspects of the economy. The analysis in the present paper of a particular acceleration proposal indicates that this claim is essentially true if the inflation rate is in the range of 4 percent to 12 percent and the investor's <u>real</u> discount rate is between 4 percent and 7 percent. With higher or lower inflation rates or real discount rates, the acceleration method can be substantially different from indexation. The accelerated depreciation schedule could of course be altered in the future if economic conditions change significantly, but the possibility of such <u>ad hoc</u> adjustments is inherently destabilizing and the lack of retroactive adjustment introduces unnecessary risks into current investment decisions.

Since the acceleration and indexation methods have quite similar effects under existing economic conditions, the choice between them requires balancing the administrative simplicity and other possible advantages of acceleration against the automatic protection that indexation offers against the risk of significant changes from the recent inflation rates and discount rates.

Bibliography

Aaron, Henry J. (ed.), Inflation and the Income Tax, The Brookins Institution, 1976.

Auerbach, Alan J., "Inflation and the Choice of Asset Life," Journal of Political Economy, 87, No. 3 (June 1979): 621-38.

Eisner, Robert, Factors in Business Investment, National Bureau of Economic Research, General Series No. 102, 1978.

Feldstein, Martin and Lawrence Summers, "Inflation, Tax Rules, and the Long-Term Interest Rate," Brookings Papers on Economic Activity, 1:1978, 61-109.

________________, "Inflation and the Taxation of Capital Income in the Corporate Section," National Bureau of Economic Research Working Paper Series, No. 312, 1979. (forthcoming in the National Tax Journal).

Fellner, William, Kenneth W. Clarkson and John H. Moore, "Correcting Taxes for Inflation," Domestic Affairs Study 34, American Enterprise Institute for Public Policy Research, June 1975.

Fischer, Stanley, "Wage Indexation and Macro-Economic Stability," in Stabilization of the Domestic and International Economy, K. Brunnner and A. Meltzer, eds. (New York: North Holland, 1977).

Galper, Harvey and John Mendenhall, "Inflation and the Tax Structure," Office of Tax Analysis Paper 19, November 1976.

Gray, J. "Wage Indexation: A Macroeconomic Approach," Journal of Monetary Economics, April 1976, 221-35.

Hall, Robert E. and Dale W. Jorgenson, "Tax Policy and Investment Behavior," American Economic Review, 57 (June): 391-414.

International Monetary Fund, "Adjustment of Taxation for Inflation," 1975.

King, Mervyn, Public Policy and the Corporation, (London: Chapman and Hall, 1977).

Nadiri, M. Ishaq and Affonso C. Pastore (eds.), "Indexation, The Brazilian Experience," Explorations in Economic Research, Vol. 4, No. 1, Winter 1977.

Samuelson, P.A., "Tax Deductibility of Economic Depreciation to Insure Invariant Valuations," Journal of Political Economy 72. No. 6 (December 1964), 604-6.

Shoven, John B. and Jeremy I. Bulow, "Inflation Accounting and Non-Financial Corporate Profits: Physical Assets," Brookings Papers on Economy Activity, 3:1975, 557-611.

Tax Foundation, Tax Revision in an Inflationary Era, 1975.

Appendix A

Total and Partial Responses of the Internal Rate of Return to Changes in Net Cost

This appendix shows how a rise in the net cost of investment affects the internal rate of return on investment in a general equilibrium context in which the price of the product can vary. The analysis here thus elaborates the remark on page 9 of the text about the importance of the elasticities of the supply of funds and the demand for the product. For simplicity, the appendix takes the wage rate as numeraire and assumes that there is only a single consumer good in the economy.[1]

Consider a "standard machine" to be one that uses one unit of labor per period, has a durability of T years, and produces output y(t) for $0 \leq t \leq T$. Let the gross price of the machine be g, the price per unit of output be constant at p and the wage rate be unity. The net operating profit (quasirent) in year t of the machine's life is thus $q(t) = p \cdot y(t) - 1$. Let the tax rate be τ, the annual depreciation deductions be d(t) and the investment tax credit be ITC. The internal rate of return on the investment (x) is then defined implicitly by:

$$g = (1-\tau) \int_0^T q(t)\, e^{-xt}\, dt + ITC + \tau \int_0^T d(t)\, e^{-xt}\, dt. \tag{A-1}$$

If the net cost of investment (c) is calculated at the same internal rate of return equation A-1 implies:

$$c = (1-\tau) \int_0^T q(t)\, e^{-xt}\, dt. \tag{A-2}$$

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[1] This ignores changes in the relative prices of the final goods produced with capital, the capital goods themselves and other goods like housing. The gross price of the investment good is treated as exogenous on the implicit assumption that the investment goods are made by labor alone. The analysis also assumes only a simple technology of production.

Thus an increase in c and an equiproportionate increase in the q(t)'s keeps the internal rate of return unchanged.

We now extend this analysis from a single standard machine to the entire capital stock. For any equilibrium age structure of the capital stock, the distribution of machine outputs (y(t)'s) remains constant and therefore the mean output remains constant at $\bar{y}$. The mean quasirent is therefore also a constant, $q=p\bar{y}-1$. On the basis of equation A-2 we can write the function relating the internal rate of return to the net cost and the average quasirent as

(A-3) $$x = x\ (q,\ c)$$

with the understanding that this function is homogeneous of degree zero in q and c.

Let the supply of capital be an increasing function of the net rate of return:

(A-4) $$K^S = S\ (x), \qquad S' \geq 0.$$

The demand for capital depends on the demand for the product[1] and therefore on the price of the product:

(A-5) $$K^D + D\ (p)\ , \qquad D' \leq 0.$$

Equating the supply and demand for capital gives the equilibrium condition:

(A-6) $$S[x(p\bar{y}-1,\ c)] = D(p)$$

Totally differentiating and collecting terms implies:

(A-7) $$\frac{dp}{dc} = \frac{\partial x/\partial c}{\bar{y}(\partial x\ /\ \partial q) - D'/S'}$$

From A-3

(A-8) $$\frac{dx}{dc} = \frac{\partial x}{\partial q}\ \bar{y}\ \frac{dp}{dc} + \frac{\partial x}{\partial c}\ .$$

Substituting A-7 into A-8 yields

[1]Recall that this is the demand for capital with a given capital-labor ratio and equivalently a given wage rate and rate of return.

(A-9)
$$\frac{dx}{dc} = \frac{\partial x}{\partial c} \; 1 - \frac{\bar{y}\,(\partial x/\partial q)}{\bar{y}\,(\partial x/\partial q) - D'/S'} \quad .$$

Before going further to simplify and interpret the right hand side of A-9, it is useful to not that when the supply of funds is infinitely elastic with respect to the net yield ($S' = \infty$), $dx/dc = 0$, i.e., the net return is unaffected by changes in the net cost of investment. Similarly, for any $S'>0$, if the demand for the product is completely inelastic, consumers bear the entire burden of any rise in c and $dx/dc = 0$.

It is easier to interpret A-9 if it is rewritten in terms of elasticities. Let $\eta_S = xK^{-1} S'$ and $\eta_D = - pK^{-1} D'$ be the relevant supply and demand elasticities. Let $e_{xq} = qx^{-1} (\partial x/\partial q)$ and $e_{xc} = q\,x^{-1} (\partial x/\partial c)$ be partial elasticities of the rate of return with respect to q and c. Let $\alpha = q/p\bar{y}$, the share of the quasirent in the total value of output. Finally, let E_{xc} be the total elasticity of the rate of return with respect to c.

Equation A-9 simplifies directly to

(A-10)
$$E_{xc} = \frac{e_{xc}}{1 - \bar{y}\,\frac{\partial x}{\partial q}\,\frac{S'}{D'}}$$

Substituting $- S'/D' = px^{-1}\,\eta_s/\eta_D$ and $\alpha = q/p\bar{y}$ yields

(A-11)
$$E_{xc} = \frac{e_{xc}}{1 + \frac{e_{xq}}{\alpha}\left(\frac{\eta_S}{\eta_D}\right)}$$

But since x is homogeneous of degree zero in c and q, $e_{xq} = - e_{xc}$ and A-11 implies

(A-12)
$$E_{xc} = \frac{e_{xc}}{1 - \frac{e_{xc}}{a}\left(\frac{\eta_S}{\eta_D}\right)}$$

The implication of $\eta_S = \infty$ and $\eta_D = 0$ have already been noted. Consider now the case of equal elasticities of supply and demand $\eta_S = \eta_D$: regardless of how large e_{xc} is, E_{xc} is absolutely less than α. For example, with short-lived investments for which the partial elasticity is a very large $e_{xc} = -10$, the total elasticity is only $E_{xc} = 10\alpha/(\alpha + 10)$. Since $\alpha \leq 1$, this is bounded by only 10/11; a more plausible value of $\alpha = 1/3$ implies $E_{xc} = 10/31$ or 0.32. Of course, this reflects the assumption that $\eta_S = \eta_D$ and a higher ratio of η_D and η_S would raise E_{xc} relative to e_{xc}. But for a wide range of plausible elasticities of supply and demand, the total response of the rate of return will be substantially smaller than the partial response.

Appendix B

After-Tax Internal Rates of Return

With Indexing and Acceleration

This appendix presents the real after-tax internal rates of return for investments under the indexing and acceleration methods of depreciation. Results are presented for assets of different life and for different inflation rates. Separate figures are given for equipment and for structures.

The gross operating profits of each investment are assumed to decline geometrically over the life of the investment. The rate of decline is the inverse of the life of the investment. The initial level of gross operating profit is selected to make the pretax internal rate of return 11 percent. The allowable tax depreciation life is assumed equal to the economic life.

The calculated internal rates of return are presented in Table B-1.

Table B-1

Real After-Tax Internal Rates of Return on Investment

in Equipment and Structures with Indexing and Acceleration

Depreciation Method	Inflation Rate	Economic Life and Allowable Depreciation Life (Years) 3	8	13	18	25	35
		Equipment					
Indexation	All	8.0	9.2	8.2	7.8	7.3	7.0
Acceleration	0	11.8	11.5	11.4	11.4	11.3	11.3
Acceleration	0.04	10.0	10.4	10.5	10.6	10.6	10.7
Acceleration	0.08	8.3	9.3	9.7	9.9	10.0	10.2
Acceleration	0.12	6.9	8.4	9.0	9.3	9.6	9.7
Acceleration	0.16	5.5	7.6	8.4	8.8	9.1	9.3
		Structures					
Indexation	All	-	5.7	5.8	6.0	6.1	6.0
Acceleration	0	-	6.2	7.2	7.7	8.1	8.4
Acceleration	0.04	-	4.8	6.1	6.8	7.4	7.8
Acceleration	0.08	-	3.6	5.2	6.1	6.8	7.3
Acceleration	0.12	-	2.6	4.5	5.6	6.3	6.9
Acceleration	0.16	-	1.8	4.0	5.1	6.0	6.6

All internal rates of return are stated as percentage rates per year. All investments have a pretax rate of return of 11 percent.